F01ZPFP

NAG Parallel Library Routine Document

Note: before using this routine, please read the Users' Note for your implementation to check for implementation-dependent details. You are advised to enclose any calls to NAG Parallel Library routines between calls to Z01AAFP and Z01ABFP.

1 Description

F01ZPFP gathers a distributed real vector y of length n to each logical processor on a two-dimensional logical processor grid. On entry, it is assumed that an identical copy of the vector is distributed in cyclic one-dimensional block form across logical processors on each row of the grid, and that the distributed vector is aligned with columns of a distributed matrix A, with the parameters of this distribution contained in a descriptor array IDESCA corresponding to A. This routine is primarily designed to be used following a call to F08FEFP (PDSYTRD) or F08FSFP (PZHETRD).

See the F08 Chapter Introduction for details of the matrix A and the associated principal submatrix A_s. The matrices A and A_s themselves are not arguments to the routine F01ZPFP. The description array IDESCA (typically, as previously used by F08FEFP (PDSYTRD) or F08FSFP (PZHETRD)) contains the necessary information to gather the distributed vector y, and hence it is an input argument to the routine F01ZPFP.

2 Specification

```
   SUBROUTINE F01ZPFP(N, IA, JA, IDESCA, BYCOL, BYALL, WORK, LWORK,
  1                   IFAIL)
   DOUBLE PRECISION   BYCOL(*), BYALL(*), WORK(LWORK)
   INTEGER            N, IA, JA, IDESCA(*), LWORK, IFAIL
```

3 Usage

3.1 Definitions

The following definitions are used in describing the data distribution within this document:

m_p	–	the number of rows in the Library Grid.
m_p	–	the number of rows in the Library Grid.
p_r	–	the row grid coordinate of the calling processor.
p_c	–	the column grid coordinate of the calling processor.
M_b^A	–	the blocking factor for the distribution of the rows of a matrix A.
N_b^A	–	the blocking factor for the distribution of the columns of a matrix A.
s_r^A	–	the row coordinate of the processor that possesses the first row of a distributed matrix A.
s_c^A	–	the column coordinate of the processor that possesses the first column of a distributed matrix A.
numroc($\hat{\ell}$,L_b^A,p,s^A,ℓ_p)	–	a function which gives the **num**ber of **r**ows **o**r **c**olumns of a distributed matrix A owned by the processor with the row or column coordinate p (p_r or p_c), where $\hat{\ell}$ is the total number of rows or columns of the matrix, L_b^A is the blocking factor used (M_b^A or N_b^A), s^A is the row or column coordinate (s_r^A or s_c^A) of the processor that possesses the first row or column of the distributed matrix and ℓ_p is either m_p or n_p. The Library provides the utility function Z01CAFP (NUMROC) for the evaluation of numroc.

3.2 Global and Local Arguments

The following global **input** arguments must have the same value on entry to the routine on each processor and the global **output** arguments will have the same value on exit from the routine on each processor:

Global input arguments: N, IA, JA, IDESCA(1), IDESCA(3:8), IFAIL

Global output arguments: BYALL, IFAIL

The remaining arguments are local.

3.3 Distribution Strategy

The distributed matrices A and A_s must satisfy the following requirements:

$M_b^A = N_b^A > 0$;
$i_A = j_A = 1$;
$s_r^A = s_c^A = 0$.

Any further constraints, as well as the above, are stated in Section 4 under each argument.

4 Arguments

1: N — INTEGER *Global Input*

On entry: n, the length of the vector y.

Constraint: N ≥ 0.

2: IA — INTEGER *Global Input*

On entry: i_A, the row index of A, that identifies the first row of the submatrix A_s, with which the distributed vector is aligned.

Constraint: IA = 1. The value of IA used in prior calls to F08FEFP (PDSYTRD) or F08FSFP (PZHETRD) must also equal 1.

3: JA — INTEGER *Global Input*

On entry: j_A, the column index of A, that identifies the first column of the submatrix A_s, with which the distributed vector is aligned.

Constraint: JA = 1. The value of JA used in prior calls to F08FEFP (PDSYTRD) or F08FSFP (PZHETRD) must also equal 1.

4: IDESCA(∗) — INTEGER array *Local Input*

Note: the dimension of the array IDESCA must be at least 9.

Distribution: the array elements IDESCA(1) and IDESCA(3),. . .,IDESCA(8) must be global to the processor grid and the elements IDESCA(2) and IDESCA(9) are local to each processor.

On entry: the description array for the matrix A. This array must contain details of the distribution of the matrix A and the logical processor grid. Typically, this should be identical to the IDESCA used in F08FEFP (PDSYTRD) or F08FSFP (PZHETRD).

IDESCA(1), the descriptor type. For this routine, which uses a cyclic two-dimensional block distribution, IDESCA(1) = 1.
IDESCA(2), the Library context, usually returned by a call to the Library Grid initialisation routine Z01AAFP;
IDESCA(3), the number of rows, m_A, of the matrix A;
IDESCA(4), the number of columns, n_A, of the matrix A;
IDESCA(5), the blocking factor, M_b^A, used to distribute the rows of the matrix A;
IDESCA(6), the blocking factor, N_b^A, used to distribute the columns of the matrix A;
IDESCA(7), the processor row index over which the first row of the matrix A is distributed;

IDESCA(8), the processor column index over which the first column of the matrix A is distributed;
IDESCA(9), the leading dimension of the conceptual two-dimensional array A.

Constraints:

IDESCA(1) = 1;
IDESCA(3) $\geq$ 0; IDESCA(4) $\geq$ 0;
IDESCA(5) $\geq$ 1; IDESCA(6) $\geq$ 1;
$0 \leq$ IDESCA(7) $\leq m_p - 1$; $0 \leq$ IDESCA(8) $\leq n_p - 1$;
IDESCA(9) $\geq$ max(1,numroc(IDESCA(3),IDESCA(5),p_r,IDESCA(7),m_p)).

5: BYCOL($*$) — DOUBLE PRECISION array *Local Input*

Note: the dimension of the array BYCOL must be at least numroc(IA−1+N,IDESCA(5),p_r,IDESCA(7),m_p).

On entry: the local parts of the vector y which has been distributed across each logical processor row and aligned with columns of the distributed matrix A.

6: BYALL($*$) — DOUBLE PRECISION array *Global Output*

Note: the dimension of the array BYALL must be at least N.

On exit: the vector y.

7: WORK(LWORK) — DOUBLE PRECISION array *Local Workspace/Local Output*

On exit: WORK(1) contains the minimum value required for LWORK.

8: LWORK — INTEGER *Local Input*

On entry: the dimension of the array WORK as declared in the (sub)program from which F01ZPFP is called.

Constraint: LWORK $\geq$ numroc(N,IDESCA(6),0,0,n_p).

9: IFAIL — INTEGER *Global Input/Global Output*

The NAG Parallel Library provides a mechanism, via the routine Z02EAFP, to reduce the amount of parameter validation performed by this routine. For a full description refer to the Z02 Chapter Introduction.

On entry: IFAIL must be set to 0, −1 or 1. For users not familiar with this argument (described in the Essential Introduction) the recommended values are:

IFAIL = 0, if multigridding is **not** employed;
IFAIL = −1, if multigridding is employed.

On exit: IFAIL = 0 (or −9999 if reduced error checking is enabled) unless the routine detects an error (see Section 5).

5 Errors and Warnings

If on entry IFAIL = 0 or −1, explanatory error messages are output from the root processor (or processor {0,0} when the root processor is not available) on the current error message unit (as defined by X04AAF).

5.1 Full Error Checking Mode Only

IFAIL = −2000

The routine has been called with an invalid value of ICNTXT (stored in IDESCA(2)) on one or more processors.

IFAIL = −1000

The logical processor grid and library mechanism (Library Grid) have not been correctly defined, see Z01AAFP.

IFAIL < 0

On entry, one of the arguments was invalid:

if the kth argument is a scalar and if this argument was invalid then, INFO = $-k$;
if the kth argument is an array and its jth element was invalid then, INFO = $-(100 \times k + j)$.

This error occured either because a global argument did not have the same value on all logical processors, or because its value on one or more processors was incorrect. An explanatory message distinguishes between these two cases.

6 Further Comments

6.1 Algorithmic Detail

This routine is based on the ScaLAPACK routine PDLARED1D, (see Blackford, *et al.* [1]).

6.2 Parallelism Detail

None.

6.3 Accuracy

Not applicable.

7 References

[1] Blackford L S, Choi J, Cleary A, D'Azevedo E, Demmel J, Dhillon I, Dongarra J, Hammarling S, Henry G, Petitet A, Stanley K, Walker D and Whaley R C (1997) ScaLAPACK Users' Guide *SIAM* 3600 University City Science Center, Philadelpia, PA 19104-2688, USA. URL: http://www.netlib.org/scalapack/slug/scalapack_slug.html

8 Example

See Section 8 of the document for F08FEFP (PDSYTRD) or F08FSFP (PZHETRD).